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First use of satellite tags to examine movement and habitat use of big skates (*Beringraja binoculata*) in the Gulf of Alaska
Marine Ecology Progress Series (2.62)

Trends and variability in demographic indicators of a recovering population of green sea turtles (*Chelonia mydas*)
Endangered Species Research (1.325)

Predicting overlap between drift gillnet fishing and leatherback turtle habitat in the California Current ecosystem
Fisheries Oceanography (2.73)

The carbonate chemistry of the "fattening line," Willapa Bay, 2011–2014
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Diet composition and foraging ecology of U.S. Pacific Coast groundfishes with applications for fisheries management
Environmental Biology of Fishes (0.914)

Geographic concentration of the Atlantic sea scallop fishery
The Review of Regional Studies (0.73)

Wastewater treatment plant effluent alters pituitary gland gonadotropin mRNA levels in juvenile coho salmon (*Oncorhynchus kisutch*)
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[An open-access, multi-decadal, three-dimensional, hydrodynamic hindcast dataset for the Long Island Sound and New York / New Jersey Harbor estuaries]

Journal of Marine Science and Engineering (NA)

[Rearing strategies alter patterns of size-selective mortality and heritable size variation in steelhead trout (*Oncorhynchus mykiss*)]

Canadian Journal of Fisheries and Aquatic Sciences (2.66)

[RNA-seq reveals differential gene expression in the brains of juvenile resident and migratory smolt rainbow trout (*Oncorhynchus mykiss*)]

Comparative Biochemistry and Physiology Part D: Genomics (2.25)

[Population-level variation in juvenile brown trout growth from different climatic regions to an experimental thermal gradient]

Environmental Biology of Fishes (1.4)

[Genomic signatures among *Oncorhynchus nerka* ecotypes to inform conservation and management of endangered populations]

Evolutionary Applications (4.572)

OAR Publications

[Hydrogen limitation and syntrophic growth among natural assemblages of thermophilic methanogens at deep-sea hydrothermal vents]

Frontiers in Microbiology (4.165)

[Atmospheric mercury measurements at a suburban site in the Mid-Atlantic United States: Inter-annual, seasonal and diurnal variations and source-receptor relationships]

Atmospheric Environment (3.062)

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Multi-year study of the dependence of sea salt aerosol on wind speed and sea ice conditions in the coastal Arctic
Journal of Geophysical Research (3.44)

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NMFS

Age estimation
Encyclopedia of Marine Mammals, 3rd Edition, Academic Press

HIGHLIGHTED ARTICLES

*First use of satellite tags to examine movement and habitat use of big skates (*Beringraja binoculata*) in the Gulf of Alaska*
Marine Ecology Progress Series (2.62)
T. Farrugia, K. Goldman, **C. Tribuzio (NMFS/AKFSC)**, and A. Seitz

- Big skates are a valuable bycatch species, managed by both NMFS and the Alaska Department of Fish and Game.
- Tagging results suggest skates move back and forth between management boundaries, within and between agency jurisdictions.
- Results are applicable to the existing skate stock assessment.

Skates (family Rajidae) are in growing demand as a food resource worldwide, specifically in European and Asian markets. Based on recent stock assessment surveys, Alaska has relatively healthy skate stocks and there is interest from the commercial fishing industry to increase skate landings from Alaska waters. Big Skate (*Beringraja binoculata*) is the most frequently landed skate in the Gulf of Alaska portion of the Northeast Pacific Ocean and is managed by two agencies, the National Marine Fisheries Service and the Alaska Department of Fish and Game. Each agency divides the non-target catch quota for Big Skate into multiple management areas and assumes limited movement of Big Skate between areas. Thus, information on movement patterns and habitat use would allow management agencies to develop appropriate spatial management plans for this species. We deployed Pop-up Archival Transmitting (PAT) tags on eight Big Skates in the Gulf of Alaska and set the tags to release one year after deployment. Three of the tagged

skates showed evidence of having crossed at least one management boundary, while three remained relatively close to their tagging locations. Two tags did not report any data. The PAT tags also extended the maximum documented depth of Big Skates to over 500 m, and confirmed that they are thermally tolerant, occupying waters between 2º and 18ºC. Managers can use this information to refine the assumptions of stock assessment models and increase the efficiency of skate fishery management.
Acceptance date: 9 August 2016
Expected publication date: November 2016

*Trends and variability in demographic indicators of a recovering population of green sea turtles (*Chelonia mydas*)*
Endangered Species Research (1.325)
S. E. Piacenza, **G. H. Balazs (NMFS/PIFSC)**, **S. K. Hargrove (NMFS/SEFSC-Miami)**, **P. M. Richards (NMFS/SEFSC-Miami)**, and S. S. Heppell

- Our results highlight the importance of carefully interpreting raw counts of sea turtle nests, as a positive trend could be attributable to increased nesting frequency (i.e. a greater breeding probability) and not necessarily due to a true increase in population abundance.

Multiple populations of green sea turtles show signs of population recovery. In Hawaii, green turtles have increased 5.4% year-1 since 1973, but wide fluctuations in census counts of nesting females make recovery diagnosis difficult. Evaluating demographic rates for temporal change and in relation to population density, and indicators of recruitment to sea turtle nesting populations will ultimately improve population assessments. Using linear mixed and multistate open robust design models, we estimated the demographic indicators (DIs) of size-at-maturity, nester carapace length, breeding probability, and adult female survival rate using 3,677 tagged nesting green turtles from 1973 - 2010 in Hawaii. To evaluate changes with density, we correlated the DIs with nesting female counts. We estimated size-at-maturity, assuming newly tagged nesters are tagged on their first nesting migration, and first-time nesters have statistically significant smaller carapace length than recaptures, but the difference in size was only ~0.5 cm year-1. Mean nester

carapace length (range: 89.21 - 91.69 cm) and breeding probability (range: 0.0766 – 0.444 year-1) showed directional changes over time, suggesting shifts in age structure that could be due to recruitment. The top-ranked model predicted constant female survival over time (S = 0.929 year-1, 95% CI: 0.924 – 0.933, model likelihood = 1.00). Counter to our hypothesis based on density-dependence, breeding probability increases with increasing nester abundance; this suggests that breeding probability is more likely driven by environmental influences than population densities, at least within the range of observed nester abundances. This work contributes to a growing set of studies evaluating sea turtle demography for temporal variability and is the first for Hawaiian green turtles. Our study demonstrates that some easily monitored demographic variables may serve as indicators of population change.
Acceptance date: 24 July 2016

Predicting overlap between drift gillnet fishing and leatherback turtle habitat in the California Current ecosystem
Fisheries Oceanography (2.73)
T. Eguchi, S. R. Benson, D. G. Foley, and **K. A. Forney (NMFS/SWFSC)**

- ESA listed Pacific leatherback sea turtles (*Dermochelys coriacea*) are a NOAA fisheries Species in the Spotlight - one of eight the listed species most at risk of extinction.
- A primary threat to Pacific leatherback turtles is commercial fishing bycatch, which has resulted in management efforts including the annual seasonal closure of the large mesh drift gillnet fishery off Oregon and central California, reducing fishing opportunities.
- Using modeling, this study found that the current closure period this fishery is the most effective at reducing leatherback bycatch while allowing fishing during low bycatch periods.

Concern over bycatch of protected species has become a key factor in shaping fisheries management decisions. In 2001, the National Marine Fisheries Service established an annual closure of a large mesh drift gillnet fishery (DGN) targeting swordfish from northern Oregon to central California between August 15 and

November 15 due to concerns of bycatch of endangered leatherback turtles (the Pacific Leatherback Conservation Area; PLCA). The spatio-temporal constraints of the PLCA were developed to encompass nearly all previously observed leatherback turtle bycatch events in the fishery. The PLCA has been effective at reducing bycatch of leatherback turtles but has reduced fishing opportunities. In this study, we examine whether the timing of the current PLCA closure is optimal for leatherback turtle conservation, by developing statistical models of leatherback turtle presence inside the PLCA based on environmental variables. We also examined finer-scale spatiotemporal patterns of potential overlap between the fishery and leatherback turtle foraging habitat using Maxent and Random Forests applied to logbook data and leatherback turtle telemetry data. Our results suggest that the temporal extent of the current static closure period is the shortest and most effective for protecting the turtles while allowing fishing during low bycatch-risk periods. We also found that it is possible to predict foraging habitat of leatherback turtles and fishing effort using environmental variables. Identification of spatial and temporal hotspots of potential overlap between fishing effort and leatherback turtle distribution can form a basis for dynamic management approaches.
Acceptance date: 22 July 2016

The carbonate chemistry of the "fattening line," Willapa Bay, 2011–2014
Estuaries and Coasts (2.245)
B. Hales, A. Suhrbier, G.G. Waldbusser, **R.A. Feely (OAR-PMEL),** and J.A. Newton

- Lack of historical data makes it difficult to discern whether ocean acidification or another unknown factor is responsible for poor oyster larval settlement in Willapa Bay, WA.
- This study finds aragonite mineral saturation state, important in the larva's ability to build their shell, in the bay from 2011-2014 is below levels shown to favor larval settlement in hatchery settings the majority of the year.
- The periods of favorable aragonite saturation correspond to times when temperatures are suboptimal for spawning, leading to the conclusion that in

the past, pre-industrial Ω_{ar} conditions were more persistently favorable for larval development and more broadly coincident with thermal optima.

Willapa Bay has received a great deal of attention in the context of rising atmospheric CO_2 and the concomitant effects of changes in bay carbonate chemistry, referred to as ocean acidification, and the potential effects on the bay's naturalized Pacific oyster (*Crassostrea gigas*) population and iconic oyster farming industry. Competing environmental stressors, historical variability in the oyster settlement record, and the absence of adequate historical observations of bay-water carbonate chemistry all conspire to cast confusion regarding ocean acidification as the culprit for recent failures in oyster larval settlement. We present the first measurements of the aqueous CO_2 partial pressure (pCO_2) and the total dissolved carbonic acid (TCO_2) at the "fattening line," a location in the bay that has been previously identified as optimal for both larval oyster retention and growth, and collocated with a long historical time series of larval settlement. Samples were collected from early 2011 through late 2014. These measurements allow the first rigorous characterization of Willapa Bay aragonite mineral saturation state (Ω_{ar}), which has been shown to be of leading importance in determining the initial shell formation and growth of larval *Crassostrea gigas*. Observations show that the bay is usually below Ω_{ar} levels that have been associated with poor oyster hatchery production and with chronic effects noted in experimental work. Bay water only briefly rises to favorable Ω_{ar} levels and does so out of phase with optimal thermal conditions for spawning. Thermal and carbonate conditions are thus coincidentally favorable for early larval development for only a few weeks at a time each year. The limited concurrent exceedance of thermal and Ω_{ar} thresholds suggests the likelihood of high variability in settlement success, as seen in the historical record; however, estimates of the impact of elevated atmospheric CO_2 suggest that pre-industrial Ω_{ar} conditions were more persistently favorable for larval development and more broadly coincident with thermal optima.

Publication Date: 10 August 2016
Available Online: http://link.springer.com/article/10.1007/s12237-016-0136-7

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ADDITIONAL ARTICLES

NMFS Publications

Diet composition and foraging ecology of U.S. Pacific Coast groundfishes with applications for fisheries management
Environmental Biology of Fishes (0.914)
J. J. Bizzarro**, M. M. Yoklavich (NMFS/SWFSC),** and **W. W. Wakefield (NMFS/NWFSC)**

- The authors studied the feeding ecology of 18 commercially important rockfish species.
- Teleost fishes, euphausiids, brachyuran crabs, and polychaetes were the most important prey groups
- The findings fill substantial data gaps in the trophic ecology and habitat-based management of commercially important species and can be used to inform future reviews of Pacific Coast groundfish essential fish habitat.

Determining the prey composition and foraging habitats of federally managed aquatic species in the United States, such as Pacific Coast groundfishes, is a required but poorly understood component of the Magnuson-Stevens Fishery Conservation and Management Act. To address this knowledge gap, we conducted a meta-analysis of the feeding ecology of 18 commercially important species and their life stages during a recent review of Pacific Coast groundfish essential fish habitat. A Major Prey Index was developed to evaluate relative importance among 47 prey taxa. Based on this metric, unidentified teleosts, euphausiids, brachyuran crabs, and polychaetes were the most important prey groups. When 14 generalized prey categories were used, fishes represented the dominant taxon (mean weight/volume = 32.3%followed by shrimps (11.5%), crabs (10.0%), and euphausiids (9.5%). PERMANOVA results indicated that species-specific differences were the primary source of dietary variability among tested variables (life stage, functional group, taxonomic group). Pacific Coast groundfishes mainly were characterized as mesopredators with estimated trophic levels ranging from 3.4 to 4.2. Foraging habitats differed significantly among functional (benthic, demersal, pelagic) and taxonomic (elasmobranch, roundfish, rockfish, flatfish)

groups. Using hierarchical agglomerative cluster analysis, we identified a trophic guild that consumes mainly polychaetes and hard-shelled molluscs (juvenile, juvenile–adult Dover sole; juvenile–adult English sole) and another that specializes on euphausiids (juvenile Pacific hake; juvenile–adult darkblotched rockfish). Our findings filled substantial data gaps in the trophic ecology and habitat-based management of commercially important species and can be used to inform future reviews of Pacific Coast groundfish essential fish habitat.
Acceptance date: 29 July 2016

Geographic concentration of the Atlantic sea scallop fishery
The Review of Regional Studies (0.73)
M. Lee (NMFS/NEFSC), C. Speir (NMFS/SWFSC), A. Carr-Harris (NMFS/NEFSC), and **S. Benjamin (NMFS/NEFSC)**

- Fishing regulations and biology can affect ports, communities, and the distribution of landings across the coast.

The concentration patterns in the Northeast US Sea Scallop industry are examined from 1996-2014 using generalized indices of concentration and exploratory spatial data analysis. Absolute and relative Theil indices of concentration are computed to describe the regional pattern of concentration within ports over time. Moran's I provides a complementary measure of concentration of activity among neighboring ports. The Moran scatterplots and confidence plots provide insight into local patterns of concentration in this industry. The analysis reveals large changes from year to year in the geographic concentration of the scallop industry, which is likely to be related to natural variability of the environment and regulations enacted by fisheries managers in response to the variability of the environment
Acceptance date: 6 August 2016

*Wastewater treatment plant effluent alters pituitary gland gonadotropin mRNA levels in juvenile coho salmon (*Oncorhynchus kisutch*)*
Aquatic Toxicology (3.451)
L. B. Harding, I. R. Schultz, **D. A. M. da Silva**, **G. M. Ylitalo**, D. Ragsdale, S. I. Harris, S. Bailey, B. V. Pepich, and **P. Swanson (NMFS/NWFSC)**

- This study identified a new sensitive molecular marker of exposure juvenile salmon to estrogenic chemicals.
- Using this marker we found that effluent from several waste water treatment plants (WWTP) in the Puget Sound region contain estrogenic chemicals that can disrupt expression of genes important for reproduction in salmon.
- The study also shows that monitoring multiple genes and tissues is important for screening for potential endocrine disrupting chemicals in the environment.

It is well known that endocrine disrupting compounds (EDCs) present in wastewater treatment plant (WWTP) effluents interfere with reproduction in fish, including altered gonad development and induction of vitellogenin (Vtg), a female-specific egg yolk protein precursor produced in the liver. As a result, studies have focused on the effects of EDC exposure on the gonad and liver. However, impacts of environmental EDC exposure at higher levels of the hypothalamic-pituitary-gonad (HPG) axis are less well understood. The pituitary gonadotropins (Gths), follicle-stimulating hormone (Fsh) and luteinizing hormone (Lh) are involved in all aspects of gonad development and are subject to feedback from gonadal steroids making them a likely target of endocrine disruption. In this study, the effects of WWTP effluent exposure on pituitary gonadotropin (Gth) mRNA expression were investigated in juvenile coho salmon (*Oncorhynchus kisutch*). First, a controlled 72-hour exposure to 17α-ethynylestradiol (EE2) and trenbolone (TREN) was performed to evaluate the response of juvenile coho salmon to EDC exposure. Second, juvenile coho salmon were exposed to 0, 20 or 100% effluent from eight WWTPs from the Puget Sound, WA region for 72 hours. Juvenile coho salmon exposed to 2 and 10 ng EE2 L^{-1} had 17-fold and 215-fold higher Lh beta-subunit (*lhb*) mRNA levels relative to control fish. Hepatic *vtg* mRNA levels were dramatically increased 6,670-fold, but only in response to 10 ng EE2 L^{-1} and Fsh beta-subunit (*fshb*) mRNA levels were not altered by any of the treatments. In the WWTP effluent exposures, *lhb* mRNA levels were significantly elevated in fish exposed to five of the WWTP effluents. In contrast, transcript levels of*vtg* were not affected by any of the WWTP effluent exposures. Mean levels of natural and synthetic estrogens in fish bile were consistent with pituitary *lhb* expression,

suggesting that the observed *lhb*induction may be due to estrogenic activity of the WWTP effluents. These results suggest that *lhb*gene expression may be a sensitive index of acute exposure to estrogenic chemicals in juvenile coho salmon. Further work is needed to determine the kinetics and specificity of *lhb* induction to evaluate its utility as a potential indicator of estrogen exposure in immature fish. Acceptance date: 21 July 2016

An open-access, multi-decadal, three-dimensional, hydrodynamic hindcast dataset for the Long Island Sound and New York / New Jersey Harbor estuaries
Journal of Marine Science and Engineering (NA)
N. Georgas , L. Yin, Y. Jiang, Y. Wang, P. Howell, **V. Saba (NMFS/NEFSC)**, J. Schute, P. Orton, and B. Wen

- A temperature increase in Long Island Sound over the past three and a half decades has been confirmed and has been found to be statistically significant from the multi-decadal simulation for Long Island Sound's physical environment performed using Stevens Institute of Technology's The New York Harbor Observing and Prediction System (NYHOPS) hindcast model.
- The linear trends have also been found to be quite high (0.34±0.08°C per decade) and comparable to those in the Gulf of Maine.
- The New York Harbor Observing and Prediction System (NYHOPS) hindcast results are in demand to support fisheries research through coupling to habitat suitability indices, population models, water quality models, or to provide boundary conditions to higher resolution embayment or tributary circulation models.

This article presents the results and validation of a comprehensive, multi-decadal, hindcast simulation performed using the New York Harbor Observing and Prediction System (NYHOPS) three-dimensional hydrodynamic model. Meteorological forcing was based on 3-hourly gridded data from the North American Regional Reanalysis of the US National Centers for Environmental Prediction. Distributed hydrologic forcing was based on daily United States Geologic Survey records. Offshore boundary conditions for NYHOPS at the Mid-Atlantic Bight shelf break comprised of hourly subtidal water levels from a larger-

scale model ran for the same period that were added to tides, while temperature and salinity profiles were based on the Simple Ocean Data Assimilation datasets. The NYHOPS hindcast's total water levels and 3D water temperature and salinity conditions were validated using over three decades of observations from multiple agencies. The average indices of agreement for storm surge, water temperature, and salinity were 0.93 (RMSE = 9 cm), 0.99 (RMSE = 1.1 °C), and 0.86 (RMSE = 1.8 psu) respectively. The model's skill in simulating bottom water temperature did not drift over the years, a significant and encouraging finding for multi-decadal model applications used to identify climatic trends such as the warming presented here. However, the validation reveals residual biases in some areas such as small tributaries that receive urban discharge from the NYC drainage network. With regard to the validation of storm surge at coastal stations, both the considerable strengths and remaining limitations of the use of NARR to force the NYHOPS model are discussed.
Publication date: 16 August 2016
Available online: http://www.mdpi.com/2077-1312/4/3/48

Rearing strategies alter patterns of size-selective mortality and heritable size variation in steelhead trout (Oncorhynchus mykiss)
Canadian Journal of Fisheries and Aquatic Sciences
B. A. Berejikian, J. J. Hard, C. P. Tatara, D. M. Van Doornik , P. Swanson, and **D. A. Larsen (NMFS/NWFSC)**

- Rearing ESA-listed steelhead trout for two years in the hatchery improves survival after transition to seawater compared to the typical practice of rearing for one year.
- The heritability of body size depends on the duration of rearing in hatchery tanks.
- Hatcheries may be able to alter rearing practices to reduce a primary component of domestication selection.

Domestication selection in cultured anadromous salmonids is widely hypothesized to result from selection favoring rapid growth rate and correlated physiological or behavioral traits. Steelhead trout (*Oncorhynchus mykiss*) were reared under two

different regimes: high food ration for one year (S1; typical strategy) or low ration for two years (S2) and subjected to a seawater challenge during the corresponding the spring outmigration period. The S1 smolts were smaller, suffered greater seawater challenge mortality (23.9% compared to 0.7% for the S2 smolts) that was significantly and negatively related to body size. Overall, heritability for challenge mortality was low (0.002; 95% credible interval: 0.001-0.589). Heritability for body size (reflecting growth rate within each rearing treatment) was similar for the two treatments during the parr stage (fork length: S1 = 0.181, S2 = 0.245; mass: S1 = 0.372; S2 = 0.447), but higher for the S1 treatment during the smolt stage for length (S1 = 0.212, S2 = 0.002) and body mass (S1 = 0.145, S2 = 0.015). General linear models confirmed strong family effects for both traits and significant family by environment interactions for parr mass and smolt length, indicating significant phenotypic plasticity. The results are consistent with the hypothesis that size-selective mortality in steelhead trout is more likely to occur where there is insufficient growth opportunity for smolts to achieve body size thresholds for smoltification (S1 treatment) and may be alleviated by an additional year of culture. A genetic response to selection in the S1 treatment is plausible, and may affect fitness in the natural environment through effects on correlated traits.
Publication date: 26 July 2016
Available online: http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2016-0175#.V8BKqk0rKUl

RNA-seq reveals differential gene expression in the brains of juvenile resident and migratory smolt rainbow trout (Oncorhynchus mykiss)
Comparative Biochemistry and Physiology Part D: Genomics (2.265)
M. Hale, G. McKinney, F. P. Thrower, and **K. M. Nichols (NMFS/NWFSC)**

- The findings of this study identify physiological differences between migrant and resident *O. mykiss* prior to migration, which is important in understanding the differences between life histories that are considered unique for conservation.

Many migratory traits are heritable, but there is a paucity of evidence identifying the molecular mechanisms underlying differentiation in alternative migratory

tactics, or in linking variation in gene expression to migratory behaviors. To that end, we examined differential gene expression in the brain transcriptome between young steelhead trout that had undergone the smoltification process, and resident rainbow trout (*Oncorhynchus mykiss*) from Sashin Creek, Alaska. Samples were sequenced from two time points: immediately before (at 20 months of age) and during (2 years of age) the presumed peak of smoltification. Smolt and resident individuals came from two genetic crosses, one where both parents were migratory, and another where both parents were residents. A total of 533 (1.9%) genes were differentially expressed between crosses, or between smolt and resident samples. These genes include some candidate migratory genes (such as *POMC*), as well as genes with no previous known involvement in the migratory process. Progeny from resident parents showed more upregulated genes than progeny from migrant parents at both time points. Pathway analysis showed enrichment in 227 biological pathways between cross type, and 171 biological pathways were enriched between residents and smolts. Enriched pathways had connections to many biofunctions, and most were only enriched in one contrast. However, pathways connected to phototransduction were enriched between both cross type and migratory tactics in 11 out of 12 contrasts, suggesting there are fundamental differences in how smolts and residents process light in the brain. The genes and pathways described herein constitute an *a priori* candidate list for future studies of migration in other populations of *O. mykiss*, and other migratory species.
Acceptance date: 22 July 2016

Population-level variation in juvenile brown trout growth from different climatic regions to an experimental thermal gradient
Environmental Biology of Fishes (1.4)
K. M. Bærum, L. A. Vøllestad, **P. M. Kiffney (NMFS/NWFSC**), A. Remy, and T. O. Haugen

- Fish and other ectothermic animals living under different temperature and precipitation regimes may vary in their response to changes in climate because they are adapted to local conditions

- We found that juvenile brown trout growth rates from different regions of Norway varied in response to simulated temperature regimes predicted by climate models

Climate-change scenarios predict increasing temperatures and more precipitation at high latitudes. Ectothermic species are highly affected by these environmental variables and due to few dispersal opportunities many populations will need to adapt to these environmental changes. Understanding if, where, and how such adaptation processes occur is important for forecasting population dynamics in a changing climate. Individual growth, a key life-history trait influencing population-level parameters is directly affected by temperature especially in ectotherms. Thermal adaptations that optimize growth are therefore expected in such organisms. However, knowledge about how ectothermic animals modify growth rate in the face of climate change is ambivalent at best for many species especially at the local population-level. Here, we present a common-garden experiment exploring variations in growth reaction norms for three populations of *Salmo trutta*, a temperate freshwater fish over three discrete temperatures. The populations originated from different climatic regions of Norway that vary in temperature and precipitation. Thermal growth reaction norms varied among populations in both slope and intercept. Specifically, populations from wetter environments showed higher growth rates compared to populations associated with drier regions. Further, evidence for a countergradient thermal growth adaptation was observed, as populations from high altitudes (i.e., short and cold growth season) grew faster at all temperatures compared to populations from low altitudes (i.e., long and warm growth season). Our models suggest that trout growth rates were more affected by precipitation than temperature suggesting precipitation may have a stronger selection potential for early juvenile growth compared to temperature in these systems.

Acceptance date: 2 August 2016

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Genomic signatures among Oncorhynchus nerka *ecotypes to inform conservation and management of endangered populations*
Evolutionary Applications (4.572)
K. M. Nichols (NMFS/NWFSC), C. C. Kozfkay, and S. R. Narum

- Alturas Lake kokanee produce a small number of migratory sockeye, which is important in considering how to restore anadromous sockeye to the Stanley Basin region.
- Migratory life history variation has been maintained in nearly extirpated populations of *Oncorhynchus nerka*; conservation efforts to preserve variation in life history is important for long-term resiliency of this species.
- However, the authors found limited evidence for parallel signatures of genomic variation associated with migration life history traits using SNPs from restriction-site associated DNA sequencing (RADseq).

Many salmonid species exhibit both resident and migratory strategies that capitalize on benefits in freshwater and marine environments. In this study, we investigated genomic signatures for migratory life history in collections of resident and anadromous *Oncorhynchus nerka* (Kokanee and Sockeye Salmon, respectively) from two lake systems, using ~2,600 SNPs from restriction-site associated DNA sequencing (RADseq). Differing demographic histories were evident in the two systems where one pair was significantly differentiated (Redfish Lake, F_{ST} = 0.091 (95% confidence interval: 0.087 to 0.095)) but the other pair was not (Alturas Lake, F_{ST} = -0.007 (-0.008 to -0.006)). Outlier and association analyses identified several candidate markers in each population pair, but there was limited evidence for parallel signatures of genomic variation associated with migration. Despite lack of evidence for consistent markers associated with migratory life history in this species, candidate markers were mapped to functional genes and provide evidence for adaptive genetic variation within each lake system. Life history variation has been maintained in these nearly extirpated populations of *O. nerka* and conservation efforts to preserve this diversity is important for long-term resiliency of this species.
Acceptance date: 25 July 2016

NOAA SCIENTIFIC PUBLICATIONS REPORT
AUGUST 29, 2016

OAR Publications

Hydrogen limitation and syntrophic growth among natural assemblages of thermophilic methanogens at deep-sea hydrothermal vents
Frontiers in Microbiology (4.165)
B.D. Topçuoğlu, L.C. Stewart, H.G. Morison, **D.A. Butterfield (OAR/CPO)**, J.A. Huber, and J.F. Holden

- Methanogens and H2-producing heterotrophs were detected at most hydrothermal vent sites at Axial Seamount.
- Growth of thermophilic and hyperthermophilic methanogens are primarily limited by H2 availability
- At 80° C microcosms, there was evidence of archaea and H2-consuming methanogens, but no bacteria, while at 55° C there were bacteria detected as well.

Thermophilic methanogens are common autotrophs at hydrothermal vents, but their growth constraints and dependence on H2 syntrophy in situ are poorly understood. Between 2012 and 2015, methanogens and H2-producing heterotrophs were detected by growth at 80°C and 55°C at most diffuse (7–40°C) hydrothermal vent sites at Axial Seamount. Microcosm incubations of diffuse hydrothermal fluids at 80°C and 55°C demonstrated that growth of thermophilic and hyperthermophilic methanogens is primarily limited by H2 availability. Amendment of microcosms with NH4+ generally had no effect on CH4 production. However, annual variations in abundance and CH4 production were observed in relation to the eruption cycle of the seamount. Microcosm incubations of hydrothermal fluids at 80°C and 55°C supplemented with tryptone and no added H2 showed CH4 production indicating the capacity in situ for methanogenic H2 syntrophy. 16S rRNA genes were found in 80°C microcosms from H2-producing archaea and H2-consuming methanogens, but not for any bacteria. In 55°C microcosms, sequences were found from H2-producing bacteria and H2-consuming methanogens and sulfate-reducing bacteria. A co-culture of representative organisms showed that Thermococcus paralvinellae supported the syntrophic growth of Methanocaldococcus bathoardescens at 82°C and

Methanothermococcus sp. strain BW11 at 60°C. The results demonstrate that modeling of subseafloor methanogenesis should focus primarily on H2 availability and temperature, and that thermophilic H2 syntrophy can support methanogenesis within natural microbial assemblages and may be an important energy source for thermophilic autotrophs in marine geothermal environments.
Publication date: 5 August 2016
Available online:
http://journal.frontiersin.org/article/10.3389/fmicb.2016.01240/full

Atmospheric mercury measurements at a suburban site in the Mid-Atlantic United States: Inter-annual, seasonal and diurnal variations and source-receptor relationships
Atmospheric Environment (3.062)
X. Ren, W. T. Luke, P. Kelley, M. D. Cohen, R. Artz, M. L. Olson, D. Schmeltz, D. L. Goldberg, A. Ring, G. M. Mazzuca, K. A. Cummings, L. Wojdan, S. Preaux, and J. W. Stehr **(OAR/ARL)**

- Decreases in gaseous elemental mercury (GEM), gaseous oxidized mercury (GOM), particulate-bound mercury (PBM), and mercury wet deposition over 2007–2015 were observed.
- Trajectory analysis shows correlation between mercury emissions and observed mercury.
- Two possible sources of GOM include direct emissions and photochemical oxidation.

Different atmospheric mercury forms have been measured at a suburban site in Beltsville, Maryland in the Mid-Atlantic United States since 2007 to investigate their inter-annual, seasonal and diurnal variabilities. Average concentrations and standard deviations of hourly measurements from 2007 to 2015 were 1.41 ± 0.23 ng m^{-3} for gaseous elemental mercury (GEM), 4.6 ± 33.7 pg m^{-3} for gaseous oxidized mercury (GOM), and 8.6 ± 56.8 pg m^{-3} for particulate-bound mercury (PBM). Observations show that on average, the rates of decrease were 0.020 ± 0.007 ng m^{-3} yr^{-1} (or 1.3 ± 0.5% yr^{-1}, statistically significant, p-value < 0.01) for GEM, 0.54 ± 0.19 pg m^{-3} yr^{-1} (or 7.3 ± 2.6% yr^{-1}, statistically significant, p-value

< 0.01) for GOM, and 0.15 ± 0.35 pg m^{-3} yr^{-1} (or 1.6 ± 3.8% yr^{-1}, statistically insignificant, p-value > 0.01) for PBM over this nine-year period. In addition, the collocated annual mercury wet deposition decreased at a rate of 0.51 ± 0.24 μg m^{-2} yr^{-2} (or 4.2 ± 1.9% yr^{-1}, statistically insignificant, p-value > 0.01). Diurnal variation of GEM shows a slight peak in the morning, likely due to the shallow boundary layer. Seasonal variation of GEM shows lower levels in fall. Both diurnal variations of GOM and PBM show peaks in the afternoon likely due to the photochemical production of reactive mercury from the oxidation of GEM and the influence of boundary layer processes. Seasonally, GOM measurements show high levels in spring and constant low levels in the other three seasons, while PBM measurements exhibit higher levels from late fall to early spring and lower levels from late spring to fall. These measurement data were analyzed using the HYSPLIT back trajectory model in order to examine possible source-receptor relationships at this suburban site. Trajectory frequency analysis shows that high GEM/GOM/PBM events were generally associated with high frequencies of the trajectories passing through areas with high mercury emissions, while low GEM/GOM/PBM levels were largely associated the trajectories passing through relatively clean areas. This study indicates that local and regional sources appear to have a significant impact on the site and these impacts appear to have changed over time, as the local/regional emissions have been reduced.
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http://www.sciencedirect.com/science/article/pii/S1352231016306215

Multi-year study of the dependence of sea salt aerosol on wind speed and sea ice conditions in the coastal Arctic
Journal of Geophysical Research (3.44)
N. W. May, **P. K. Quinn (OAR/PMEL),** S. M. McNamara, and K. A. Pratt

- Local sea ice coverage and wind speed are controlling factors for Arctic sea salt concentrations.
- Sea salt aerosol is produced from sea ice leads at wind speeds greater than 4 m s^{-1}.

- The influence of long-range transported sea salt aerosol was greatest during periods of lower winds and increased sea ice coverage.

Thinning of Arctic sea ice gives rise to ice fracturing and leads (areas of open water surrounded by sea ice) that are a potential source of sea salt aerosol. Atmospheric particle inorganic ion concentrations, local sea ice conditions, and meteorology at Barrow, AK, from 2006 to 2009, were combined to investigate the dependence of submicron (aerodynamic diameter < 1 μm) and supermicron (aerodynamic diameter 1–10 μm) sea salt mass concentrations on sea ice coverage and wind speed. Consistent with a wind-dependent source, supermicron sea salt mass concentrations increased in the presence of nearby leads and wind speeds greater than 4 m s^{-1}. Increased supermicron and submicron sea salt chloride depletion was observed for periods of low winds or a lack of nearby open water, consistent with transported sea salt influence. Sea salt aerosol produced from leads has the potential to alter cloud formation, as well as the chemical composition of the Arctic atmosphere and snowpack.
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http://onlinelibrary.wiley.com/doi/10.1002/2016JD025273/abstract

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NMFS PUBLICATIONS

Age Estimation
Encyclopedia of Marine Mammals, 3rd Edition, Academic Press
A. Hohn (NMFS/SEFSC-Beaufort)

- This chapter provides an updated overview of age estimation in marine mammals as a handy reference or introduction to the topic.

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